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1

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PLANETARY GEARING

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Our invention relates generally to planetary gearing and more particularly to planetary gearing having herringbone or self-aligning type gear teeth. Our planetary gearing is especially suitable for, but not limited to, use as a reduction gear unit between a gas turbine engine and a propeller.

In such a reduction gear unit as in practically all machinery, it is desirable to have the parts capable of axial adjustment. This is desirable among other reasons because the parts will usually experience differential thermal expansion. The differential thermal expansion may be due to use of different materials throughout the gear box unit, different temperature levels at different points in the gear box unit or a variety of reasons. In a reduction gear box for a turboprop, the torque loadings on the gear teeth are usually relatively high and it is desirable to have the axial adjustment made without additionally loading the already highly loaded gear teeth.

Our invention is directed primarily toward providing this capability in a planetary gear set. We are primarily concerned with suitably mounting a planetary gear set of the herringbone or self-aligning type within a housing while at the same time accommodating for differential thermal expansion or axial adjustment of the elements thereof without adding any load to the gear teeth of the gear train.

Other objects and features of the invention will become apparent to those skilled in the art as the disclosure is made in the following detailed description of a preferred embodiment of the invention as illustrated in the accompanying sheet of drawings in which:

FIGURE 1 is a view in cross section of a gear train mounted in its housing in accordance with our invention.

FIGURE 2 is a section taken along the line 2—2 of FIGURE 1 and looking in the direction of the arrows.

FIGURE 3 is a section taken along the line 3—3 of FIGURE 1 and looking in the direction of the arrows.

Our reduction gear includes a housing generally indicated at **12**. The housing **12** is made in two main sections **14** and **16** which are bolted together so as to mount a heavy vertical wall **18** between them. A pinion gear **20** has its forward end journaled in a roller bearing **22** mounted in the lower end of the vertical wall **18**. The aft end of the pinion gear **20** is journaled in a second roller bearing **24** mounted in the rear vertical wall **17** of the housing **12**. Input shaft **26** extends through the wall **17** into the hollow annular pinion gear **20** and is splined to it at its forward end **28**. An accessory drive gear **30** is secured to the forward end of the input shaft **28** ahead of the pinion gear **20**. The gear **30** meshes with a second gear (not shown) to drive an accessory and as such is a power take-off. The manner of connecting the accessory drive gear **30** to the input shaft **26** can best be understood by reference to FIGURE 2 in connection with FIGURE 1.

As is evident from FIGURE 1, the gear **30** has an integral axially extending portion **32** which has its inner end disposed between the pinion gear **20** and the input shaft **26**. Adjacent this inner end is an inwardly extending flange **34** which is castellated to provide circumferentially spaced slots **36**. This is best seen in FIGURE 2. Lugs **38** extending axially from the input shaft **26** are disposed in the slots **36** and together with the castellations present a continuous inner circumferential surface. The continuous

2

inner circumferential surface has a radial groove formed by aligned grooves in the individual castellations **34** and the lugs **38**. The radial groove receives a snap ring **40** which thus connects the parts. A cuplike member **42** is nested in the input shaft **26** between the snap ring **40** and an internal shoulder on the input shaft **26**. The member **42** serves as an oil puddler abutment for the inside of shaft **26**.

The gear **32** being connected to the shaft **26** also positively locates pinion gear **20** axially with respect to shaft **26** since the internal splines **28** on the gear **20** are sandwiched between the inner end of the gear **32** and a radial boss **29** on the shaft **26**. The shaft **26** in turn is axially fixed with respect to the housing **12** by a thrust bearing (not shown). The pinion gear **20** is seen to comprise a pair of axially spaced circumferential rows of teeth **44** and **46**, respectively. The teeth on this gear as well as the teeth on the remaining gears are of the herringbone type, that is, the left row **44** has a lead opposite to the lead of the right row. This gives a self-aligning feature to all of the gears.

The pinion gear **20** meshes with a large main gear **48** which has an integral hollow shaft **50**. The shaft **50** carries the inner races of roller bearings **52** and **54** at its forward and aft ends, respectively. The outer race of the roller bearing **52** is mounted in the vertical wall **18** while the outer race of the roller bearing **54** is mounted in the rear housing wall **17**. Thus the gear **48** and shaft **50** is journaled in the housing **12**. It is fixed axially with respect to the housing **12** by being in mesh with axially fixed pinion **20** through herringbone gear teeth.

Noting the detail of the aft roller bearing mount **54**, we see that the outer race is clamped between a pair of members **56** and **58** which are bolted to the rear housing wall **17**. The rightmost member **58** is cup shaped and has an integral axial flange **60** at the middle of its bottom wall. The inner surface of flange **60** is splined and receives mating splines on an oil supply tube **62** to nonrotatably mount it. The oil supply tube communicates with an oil supply chamber **64** in the rear wall **17** of the housing **12** with the bottom wall of the cupped member **58** sealingly engaging the back wall **17** to prevent leakage of oil as it flows from chamber **64** into tube **62**. The tube **62** extends to the left and is disposed within shaft **50** and a short coupling shaft **66**.

The short hollow coupling shaft **66** connects the main gear **48** with a sun gear **68**. It is drivingly connected to the main gear shaft **50** by mating internal and external splines **70** on the respective members. The coupling shaft **66** and the main gear shaft **50** are fixed axially by a buried Spiralox snap ring **72** (see FIGURES 1 and 3). The inner circumference of the forward end of the integral main gear shaft **50** is grooved at **74**. The mid portion of the outer circumference of the coupling shaft **66** has an outward boss **75** which contains a like groove **76**. The face of the shaft **50** is slotted at **78** to the depth of the groove **74**. Likewise the face of the boss **75** on the coupling shaft **66** is slotted at **80** to a depth of the groove **76**. In coupling the members **66** and **50**, they are adjusted so that the grooves **74** and **76** are in axial alignment and the slots **78** and **80** are in circumferential alignment. The Spiralox snap ring **72** is then fed through the opening created by the aligned slots **78** and **80** into the aligned grooves **74** and **76**. The parts are thus connected axially. It is to be understood that while we have shown two diametrically opposed pairs of slots **78** and **80**, two pairs of slots are not necessary. The pairs of slots are utilized for balance purposes only since a single pair of slots is all that is required to make the connection.

As stated above, the sun gear **68** is connected to the coupling shaft **66** which in turn is connected to the main